International Journal on Food, Agriculture, and Natural Resources
Volume 04, Issue 04, Page 51-61
ISSN: 2722-4066
http://www.fanres.org

Original Paper

Unveiling the Nexus: How Extension Delivery Methods Drive the Adoption of Improved Agronomic Practices among Cocoa Farmers in Ghana

Rebecca Obeng Agyei, Kwadwo Amankwah[1], Enoch Kwame Tham-Agyekum[1], Esther Narh, Jonathan Quaye[1], John-Eudes Andivi Bakang[1]*

1) Department of Agricultural Economics, Agribusiness and Extension, KNUST-Kumasi, Ghana

*) *Corresponding Author: ektagyekum@knust.edu.gh*

Received: 22 June 2023; Revised: 12 December 2023; Accepted: 23 December 2023
DOI: *https://doi.org/10.46676/ij-fanres.v4i4.189*

***Abstract*—The aim of this research is to investigate how different methods of delivering agricultural extension services influence the adoption of improved farming practices by cocoa farmers in the Bono Region. The study used data from 401 cocoa farmers selected through the multi-stage sampling technique. Generally, extension agents use farm visits and group meetings to facilitate the training of farmers on improved agronomic practices. Due to that, farmers perceived the use of farm visits and group meetings to be effective. We also found that farmers had a high level of knowledge of agronomic practices. The Tobit regression model was used to determine the effect of extension delivery methods on the adoption of improved practices. The significant relationship found in this study between farm visits, group meetings, and the adoption of improved agronomic practices underscores the importance of targeted extension strategies that incorporate personalised interactions and group-based learning approaches to effectively promote agricultural innovation and sustainable farming practices. We recommend that the extension officers frequently pay visits to the farmers and organise group meetings to improve the adoption of improved agronomic practices.**

***Keywords*—Adoption, agronomic practices, cocoa farmers, Extension delivery methods**

I. Introduction

Agricultural extension delivery methods refer to the provision of information and training to farmers through various channels, such as radio, demonstrations, and on-farm adaptive research, to improve their cropping systems and promote agricultural development [4, 30]. Agricultural extension delivery methods are important because they contribute to improvements in farmer productivity, incomes, and food security. For example, extension methods have been correlated with the adoption of improved varieties of sorghum and millet in Sudan and the cropping systems of farmers in Nigeria [26, 28]. Rapid and efficient transfer of advanced knowledge to the farmer and the potential for improved information benefit both farmers and society [33, 43]. Additionally, studies show that participating in agricultural extension programmes has positive economic gains for farmers [26, 28].

Agricultural extension delivery methods have played a crucial role in the development of the cocoa sector in Ghana. The cocoa industry has been a significant contributor to the country's economy, with Ghana being the second-largest producer of cocoa in the world. The development of agricultural extension delivery methods in the cocoa sector has been a continuous process that has evolved over time. During the colonial era in Ghana, the government established experimental stations to research the cultivation and management of cocoa, and extension agents were appointed to educate farmers on best practices in cocoa farming, including planting, pruning, and pest control [15]. However, the delivery of extension services was limited in scope and did not reach many cocoa farmers. In the post-independence era, the Ghana Cocoa Board (COCOBOD) was established in 1947 to regulate and promote the cocoa industry. COCOBOD took over the responsibility of providing extension services to cocoa farmers from the government. The extension services provided by COCOBOD included the establishment of demonstration farms, the distribution of seedlings and fertilisers, and training on best practices in cocoa farming. The extension services were delivered through various methods, including radio broadcasts, print media, and field demonstrations. In recent years, COCOBOD has continued to develop and improve its extension services. In 2014, COCOBOD launched the Cocoa Management System (CMS), a digital platform that provides real-time information on cocoa farming practices to extension agents and farmers. The CMS has improved the delivery of extension services by enabling extension agents to communicate more effectively with farmers and providing farmers with up-to-date information on best practices in cocoa farming.

A number of studies show that agricultural extension delivery methods can be effective tools for improving farmer productivity, incomes, and food security [26, 28]. Others have highlighted the relationships between extension delivery methods and the adoption of good agronomic practices in cocoa production in Ghana [11, 5, 28]. For instance, [11] reviewed extension activities in cocoa farming, including educational campaigns on farmers' farms and on radio, the use of farmer field schools, active participation in the government's programme to control cocoa pests and diseases, the launch of the cocoa farmer's newspaper, on-farm studies, and various socioeconomic surveys. Farmers reported better control of diseases and pests on their farms, which they attributed in part to CRIG extension operations [12]. [5] investigated the reasons behind the low adoption of the cocoa production technology that the Cocoa Research Institute of Ghana (CRIG) had advised cocoa farmers to use. According to them, factors such as credit, the number of cocoa farms a farmer owns, his or her gender, the age of the farm, migration, the size of the farm, and the yield of the farm all had an effect on the farmers' decisions to embrace the CRIG-recommended technologies. Another study by [28] examined the impact of agricultural extension delivery methods on farmers' cropping systems for arable crops in Nigeria. Extension delivery methods used by the agencies included demonstrations (88.4%), adopted villages (81.5%), on-farm adaptive research (75%), and groups (70%). Agricultural extension delivery and correlation coefficient analysis showed a strong link (P 0.01) between the ways that agricultural extension workers delivered information and the crops that farmers in the study area grew.

According to the previous studies, it is crucial to have knowledge about farmer-friendly extension practices in order to conduct extension programmes that cater to farmers' needs and promote change [6]. Again, determining the most effective extension delivery methods to aid adoption of good agronomic practices is a subject that has not seen much research. There is also little information available on the relationships between extension methods and the adoption of cocoa agronomic practices. In furtherance of the need for further research, this study examines the influence of extension delivery methods on the adoption of cocoa agronomic practices in Ghana. Specifically, the study seeks to analyse the extension delivery methods used in promoting good agronomic practices among cocoa farmers, estimate farmers' perceptions about the effectiveness of these methods, estimate the extent of adoption of good agronomic practices, determine the effect of the use of extension delivery methods on the adoption of agronomic practices, determine the effect of the use of extension delivery methods on the adoption of improved practices, and analyse constraints associated with the use of each extension delivery. Specialists in cocoa extension and other interested parties will use the study's findings to improve extension services. Agronomic practices would be enhanced through responsive extension delivery, and cocoa farmers' output and earnings would rise. The nation's output and foreign exchange reserves would increase with an increase in farmer adoption rates.

II. MATERIALS AND METHODS

A. *Study Area*

Three cocoa districts in the Bono Region—Sunyani, Berekum, and Dormaa Ahenkro—were chosen for the study. From each cocoa district, five communities were chosen as follows: Anyinasu, Kutire, Amomaso, Kato, and Benkasa (Berekum); Tuobodom, Yawhima, Chiraa, Odumasi, and Kwatire (Sunyani); Issahkrom, Aboabo No. 2, Aboabo No. 4, Nsuhia, and Asensu No. 1 (Dormaa Ahenkro). The population of the study area, as reported by [18], is 1,208,649 people. Farmers make up the majority of the population in the study area, and the most important crops are maize, cassava, cashew, cocoa, coconut, and animal raising. The majority of the population in the Bono Region is adult, with ages ranging from 15 to 64. The population of the research region is divided into three age groups: 0 to 14 years (426,676 inhabitants), 15 to 64 years (625,215), and 65 and older (54,582 persons). Males (596,676 residents) and females (611,973 residents) make up the study area's population, respectively (Ghana Statistical Service, 2021).

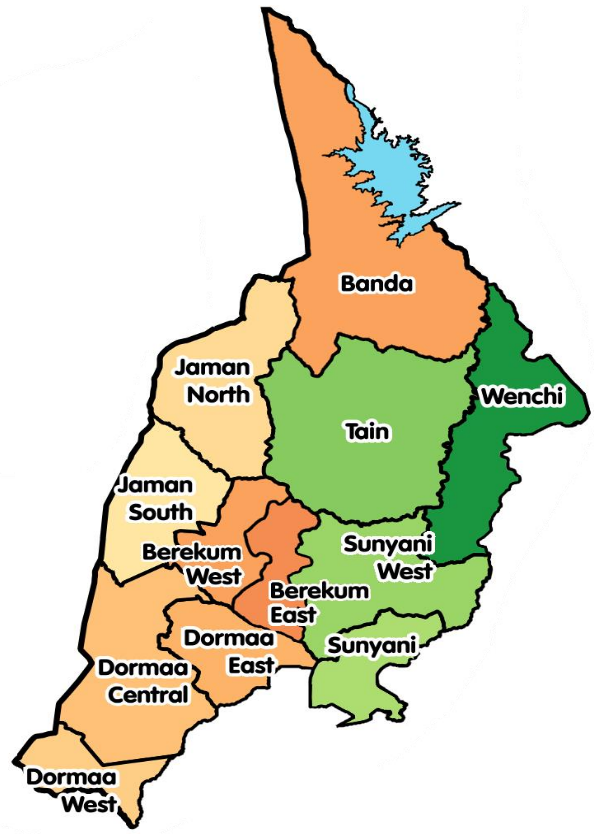

Fig. 1. A map of Bono Region

B. *Population, Sample Size and Sampling Procedure*

The study encompassed all cocoa farmers located in the Sunyani, Berekum, and Dormaa Ahenkro Districts within the Bono Region. The sample size, determined using the Yamane formula, amounted to 397. In order to determine the sample size, we added a 1% non-compliance rate to obtain 401 farmers.

The study's design was cross-sectional. The study design establishes the framework for conducting the study and ensures that the findings systematically address the study's hypothesis or research questions [2]. The Bono Region's cocoa farmers served as the study's target group. In the investigation, a multistage sampling technique was adopted. The first step was a purposive sampling of three cocoa areas in the Bono Region that are highly known for their cocoa production. In the second stage, localities within the three cocoa districts were chosen using a simple random selection technique. The respondents were chosen in the third stage using the simple random sample technique from a sampling frame or list of cocoa producers that had been collected from each Cocoa District office.

C. Research Instrument and Data Collection Procedure

Data were gathered by conducting in-person interviews with cocoa farmers using a structured questionnaire. In order to reduce negative inclinations, [35] states that when choosing how to gather data, the researcher must keep in mind the social context and the people they will be working with. This was taken into account when selecting the data collection technique. The number of questions needed to gather data, the type of questions needed to collect data, and the size of the sample needed for analysis all had an impact on the decision to use a questionnaire [19]. The questionnaire functions effectively as a data collection instrument for gathering data that can be statistically quantified. It is a useful tool in that it allows for quick contact with a large number of responders [38]. Participants were given explanations in Twi (the local language) about the study's goal and safety, as well as the risks, rewards, and advantages. 20 to 30 minutes were spent on the interview.

D. Data Analysis and Empirical Framework

The data analysis was performed using STATA 16 software. The information from the questionnaires was coded and entered into STATA for further analysis, depending on the specific objectives of the study. In order to analyse the data, the researcher used both descriptive and inferential statistical tools.

A 3-point Likert scale (1 = never, 2 = sometimes, and 3= always) was used to analyse the extent of use of the extension delivery methods and the extent of adoption of the improved agronomic practices. Also, a 5-point Likert scale (Not very effective = 1, Not effective = 2, Neither agree nor disagree = 3, Effective = 4, Very effective = 5) was used to analyse farmers perceptions about the effectiveness of the delivery methods. The overall perception index was calculated using the formula.

$$PI\,\frac{(fn \times 1) + (fs \times 2) + (fa \times 3)}{x}$$

PI= Perception index, fn= frequency of Never, fs=frequency of Sometimes, fa= frequency of Always, and x= number of respondents.

$$PI\,\frac{(fnve \times 1) + (fne \times 2) + (fna/d \times 3) + (fe \times 4) + (fve \times 5)}{x}$$

PI= Perception index, fnve= frequency of Not very effective, fne=frequency of Not effective, fna/d= frequency of Neither agree nor disagree, fe= frequency of Effective, fve= frequency of Very effective, and x= number of respondents.

A tobit regression model was used to examine the impact of different extension delivery strategies on the adoption of enhanced agronomic practices. The Tobit model pertains to regression models where the dependent variable is subject to constraints on its range. The tobit model is a commonly employed regression model that is appropriate for evaluating dependent variables with upper or lower bounds. This tackles both the investigation into the factors that impact a decision and the variables that establish the result of that decision. The model presupposes a Gaussian distribution of mistakes and a linear correlation between the independent and dependent variables. Moreover, the selection of Tobit regression was made after a meticulous analysis of the data's features and the attributes of the dependent variable. The adoption index is the dependent variable in this study, and it is subject to censoring at zero as the lower limit and at one as the upper limit [42].

The general form of the Tobit model can be expressed as follows:

For uncensored observations (Y > 0):

$Y^* = X\beta + \varepsilon$

For censored observations (Y = 0):

$Y^* = X\beta + \varepsilon$

Y = 0

In these equations:

Y* represents the latent or unobserved variable that follows a linear regression model.

Y represents the observed dependent variable (adoption of improved practices) that is subject to censoring.

X represents the matrix of independent variables, including the extension delivery methods and any other predictors.

β represents the vector of coefficients to be estimated.

ε represents the error term, assumed to follow a normal distribution with mean 0 and constant variance.

TABLE I. TOBIT REGRESSION ESTIMATES

Explanatory Variable	Measurement	Expected Sign
Sex	Dummy: 1=male, 0=otherwise	+/-
Age	Years	+/-
Religion	Dummy: 1=Christian, 0=Others	+/-
Educational level	Dummy: 1= formal education, 0=No formal education	+
Marital status	Dummy: 1= Married, 0=Others	+
Farm experience	Years	+
Household size	Number of household members	+
Farm size	Acres	+
Total yield	Bags	+/-

Source: Authors' Construct, 2022

Kendall's coefficient of concordance was used to analyse the constraints associated with the use of extension delivery methods.

The Kendall's W is estimated as:

$$w = \frac{12\sum {R_i}^{-2} - 3N(N-1)^2}{N(N-1)}$$

where: W = Kendall's value

N = total sample size

R= mean of the rank

The Kendall's W indicates the level of agreement among the farmers of the rankings obtained. Appropriately, a higher Kendall's W denotes high level of agreement on the rankings.

III. RESULTS AND DISCUSSION

A. Demographic Background Of Farmers

TABLE II. DEMOGRAPHIC BACKGROUND OF FARMERS

Categorical variables	**Freq.**	**Percent**
Sex		
Male	247	61.75
Female	153	38.25
Age		
20 - 30 years	18	4.5
31 - 40 years	55	13.75
41 - 50 years	103	25.75
51 - 60 years	147	36.75
61 and above	77	19.25
Religion		
Christian	304	76
Muslim	80	20
Traditional	16	4
Education		
No formal education	137	34.25
Primary	163	40.75
Middle school/JHS	64	16
Secondary school level	14	3.5
Tertiary	22	5.5
Marital status		
Married	281	70.25
Single	86	21.5
Divorced	19	4.75
Widowed	14	3.5
Household size		
1-5 members	199	49.87
6-10 member	155	38.85
11-15 members	34	8.52
16 and above	12	2.76
Total yield		
1 - 10 bags	169	42.78
11 - 29 bags	140	35.44
30 - 49 bags	53	13.42
50 or more bags	33	8.35
Variables	**Mean**	**Std. Dev.**
Farm experience	19.584	10.227
Land size	11.603	10.26

Source: Field Data, 2022

Table II provides a detailed breakdown of the demographic characteristics of cocoa farmers in the study area. The table indicates that the majority of farmers were male, comprising 61.75% of the total respondents. Sex has been recognised as an important factor in agricultural development and technology adoption. Studies have shown that gender roles, access to resources, decision-making power, and social norms can significantly influence the adoption of improved agricultural practices. For instance, research has highlighted the importance of gender-responsive extension approaches and interventions that address gender-specific constraints to enhance technology adoption and agricultural productivity [16, 20]. This is consistent with the common perception that men have greater access to land and resources, which enables them to engage in cocoa farming [40]. Additionally, cocoa farming is a labour-intensive activity that requires significant physical strength and endurance, which may explain the preponderance of male farmers.

The findings presented in Table II reveal that a significant proportion of farmers fall within the age range of 51–60 years. This finding aligns with [1], who noted that cocoa farmers tend to be older, emphasising the need for younger individuals to enter the farming profession. According to [21], who emphasized the lack of labor in rural areas as a result of the active population's migration in search of better opportunities, the presence of older farmers can have a negative impact on labor availability. Age is a factor that can influence various aspects of farmers' behaviour, such as their knowledge, experience, and willingness to take risks, and openness to adopting new technologies. The influence of age on technology adoption has been examined in previous studies, yielding mixed results. Some studies suggest a positive relationship between age and adoption, attributing it to the greater experience and knowledge of older farmers. Conversely, other studies propose a negative relationship, suggesting that older farmers tend to be more risk-averse and resistant to change. The findings provided evidence that the engagement of young farmers in agriculture was minimal, which is consistent with the observations made by [34].

Regarding education, the results indicate that the literacy level in the study area is high, with 40.75% of farmers having at least primary education. However, only 5.5% of farmers had tertiary education, highlighting the limited access to higher education opportunities in the area. This finding is consistent with previous research on rural areas in Ghana, which has highlighted the challenges faced by individuals seeking to access higher education [39]. The [24] highlights the significant influence of respondents' education on the acquisition and utilisation of information, including the adoption of technology.

Moreover, table II shows that most cocoa farmers in the study area were married, constituting 70.25% of the total respondents. This finding is consistent with [16], who argues that individuals who engage in agricultural activities are often married. This could be since married individuals have greater access to resources and are more likely to have established households and families, which makes them more invested in the success of their farming activities.

In the study area, households with less than 5 persons were 49.87%, 6-10, 11-15, and 16 and above were 38.85%, 8.52, and 2.76%, respectively. Household size can affect farmers' labour availability, resource allocation, and the division of tasks within the household. Larger households may have more labour resources, enabling them to adopt and implement improved agricultural practices more effectively. However, household size can also pose challenges in terms of resource scarcity and decision-making processes.

The farmers have a total yield that falls between 1 and 10 (42.78%), 11 and 29 (35.44%), 30 to 49 (13.42%), and 50 and above (8.35%). In addition, data indicates the majority of respondents had total yields of 1 to 10 bags of cocoa. The total yield variable indicates the range of agricultural yields that farmers produce. Total yield is a metric for agricultural production and is susceptible to a number of variables, including the adoption of better procedures. Crop yields may rise as a result of the use of technology like better seeds, fertilisers, and insect control techniques. According to [36] and [8], research on the relationship between crop yield and technology adoption frequently looks at how certain practices or technologies affect productivity as well as the variables that affect farmers' decisions to accept or not adopt these practices.

The majority have enough experience with their farming activities, and the average number of years they have been farming is 19.58, suggesting that they may have picked up the skills necessary to successfully manage their farms over time. Because it affects farmers' knowledge, abilities, and comprehension of local conditions, farm experience can be a significant factor in technology adoption. Farmers with more experience could have amassed information about regional agro-ecologies, crop management techniques, and efficient decision-making techniques. According to studies by [22] and [25], there is a correlation between farm experience and the adoption of technology. Experienced farmers are more likely to adopt new methods.

The analysis of the data showed that, on average, cocoa farmers in the Bono Region have 11.6 acres of land, or 4.7 hectares, most of which are family farms that they have inherited from their parents or grandparents. According to [17], Ghana's cocoa farms are typically only 0.4 to 4.0 ha in size. According to [41], a large percentage of respondents (70.33 percent) possessed cocoa farms with a size between 1 and 5 hectares, correlating with the findings of the study in the Bono Region. Land size can influence farmers' capacity to adopt and implement improved practices, as it determines the scale and scope of agricultural activities. Larger landholders may have more resources and incentives to adopt mechanisation, precision agriculture, or other innovative practices. Conversely, small-scale farmers may face resource constraints and limited access to credit or inputs, which can affect their ability to adopt certain technologies.

B. Analysis Of The Extent Of Usafe Of Extension Methods For Delivery Of Improved Agronomic Practices

TABLE III. EXTENT OF USAGE OF EXTENSION METHODS FOR DELIVERY OF GOOD AGRONOMIC PRACTICES

Practices	**Never (1)**	**Sometimes (2)**	**Always (3)**	**Mean (SD)**
Home visits	139 (34.75)	204 (51)	57 (14.25)	1.8 (0.67)
Farm visits	23 (5.75)	201 (50.25)	176 (44)	**2.38** (0.59)
Group meetings	28 (7)	212 (53)	160 (40)	**2.33** (0.6)
Durbars	98 (24.5)	220 (55)	82 (20.5)	1.96 (0.67)
Radio talks	140 (35)	159 (39.75)	101 (25.25)	1.9 (0.77)
Mean index for weeding				2.074 (0.24)
Home visits	118 (29.5)	240 (60)	42 (10.5)	1.81 (0.6)
Farm visits	21 (5.25)	112 (28)	267 (66.75)	**2.62** (0.59)
Group meetings	10 (2.5)	199 (49.75)	191 (47.75)	**2.45** (0.55)
Durbars	56 (14)	254 (63.5)	90 (22.5)	2.09 (0.6)
Radio talks	83 (20.75)	213 (53.25)	104 (26)	2.05 (0.68)
Mean index for pruning				2.204 (0.29)
Home visits	135 (33.75)	205 (51.25)	60 (15)	1.81 (0.67)
Farm visits	20 (5)	178 (44.5)	202 (50.5)	**2.46** (0.59)
Group meetings	15 (3.75)	222 (55.5)	163 (40.75)	**2.37** (0.56)
Durbars	65 (16.25)	242 (60.5)	93 (23.25)	2.07 (0.63)
Radio talks	115 (28.75)	180 (45)	105 (26.25)	1.98 (0.74)
Mean index for mistletoe removal				2.138 (0.24)
Home visits	123 (30.75)	209 (52.25)	68 (17)	1.86 (0.68)
Farm visits	22 (5.5)	191 (47.75)	187 (46.75)	**2.4**1 (0.59)
Group meetings	10 (2.5)	213 (53.25)	177 (44.25)	**2.42** (0.54)
Durbars	69 (17.25)	231 (57.75)	100 (25)	2.08 (0.65)
Radio talks	91 (22.75)	200 (50)	109 (27.25)	2.05 (0.71)
Mean index for pest and disease				2.164 (0.22)
Home visits	108 (27)	245 (61.25)	47 (11.75)	1.85 (0.6)
Farm visits	13 (3.25)	135 (33.75)	252 (63)	**2.6** (0.55)
Group meetings	7 (1.75)	179 (44.75)	214 (53.5)	**2.52** (0.53)
Durbars	59 (14.75)	243 (60.75)	98 (24.5)	2.1 (0.62)
Radio talks	76 (19)	217 (54.25)	107 (26.75)	2.08 (0.67)
Mean index for fertilizer application				2.23 (0.28)

Home visits	164 (41)	188 (47)	48 (12)	1.71 (0.67)
Farm visits	25 (6.25)	196 (49)	179 (44.75)	**2.39 (0.6)**
Group meetings	11 (2.75)	241 (60.25)	148 (37)	**2.34 (0.53)**
Durbars	83 (20.75)	224 (56)	93 (23.25)	2.03 (0.66)
Radio talks	134 (33.5)	165 (41.25)	101 (25.25)	1.92 (0.76)
Mean Index for pod and sanitary harvest				2.078 (0.26)
Overall mean index				2.148 (0.26)

Source: Field Data, 2022

*Scale: 1 = Never; 2 = Sometimes; 3 = Always

Table III shows that the usage of extension methods (i.e., home visits, farm visits, group meetings, durbars, radio talks) recorded an overall mean index of 2.15 for delivery of messages on good agronomic practices (i.e., weeding, pruning, mistletoe removal, pest and disease, fertiliser application, pod, and sanitary harvest). This overall mean index shows that sometimes these methods were used to deliver good agronomic practices.

The mean index value of 2.074 for weeding suggests that extension methods are sometimes utilised to convey messages related to weeding to cocoa farmers. This value indicates a moderate level of usage of these extension methods in the context of communicating weeding information. However, farm visits and group meetings were the ones that were sometimes used for the delivery of the messages on weeding. Numerous studies have examined the importance of farm visits and group meetings in agricultural extension programmes. These methods allow for direct engagement, knowledge sharing, and personalised support, which can enhance farmers' understanding and adoption of recommended practices. Farm visits provide an opportunity for extension agents to observe and provide tailored advice based on the specific conditions of farmers' fields, while group meetings foster peer learning and collaboration among farmers.

However, farm visits and group meetings recorded a mean index of 2.62 and 2.45, respectively, for the delivery of messages on pruning. Additionally, the mean index (2.204) for pruning shows that all these delivery methods are sometimes used for the delivery of information on pruning. Also, the mean index for removal of mistletoe (2.138), pests and diseases (2.164), fertiliser application (2.23), and pod and sanitary harvest (2.078) indicates that all these delivery methods are used to sometimes deliver information regarding removal of mistletoe, pests and diseases, fertiliser application, and pod and sanitary harvest. However, farm visits and group meetings were the most frequent methods used for the delivery of messages on pests and diseases. Referemce [3] found that farm visits and group meetings were among the most used extension methods in Ghana, along with field days and demonstrations. Similarly, another study by [32] on the adoption of improved cocoa farming practices in Ghana found that farmers who participated in group meetings and farm visits were more likely to adopt these practices than those who did not.

C. Farmers' Perception About The Effectiveness Of The Extension Delivery Methods

TABLE IV. FARMERS' PERCEPTION ABOUT THE EFFECTIVENESS OF THE EXTENSION DELIVERY METHODS

Perception statement	**NVE**	**NE**	**NAD**	**E**	**VE**	**Mean**
Home visits	40 (10)	70 (17.5)	62 (15.5)	168 (42)	60 (15)	3.35
Farm visits	9 (2.25)	13 (3.25)	34 (8.5)	161 (40.25)	183 (45.75)	**4.24**
Group meetings	12 (3)	25 (6.25)	20 (5)	196 (49)	147 (36.75)	**4.10**
Durbars	51 (12.75)	77 (19.25)	35 (8.75)	182 (45.5)	55 (13.75)	3.28
Radio talks	64 (16)	73 (18.25)	63 (15.75)	128 (32)	72 (18)	3.18
Index for weeding						**3.63**
Home visits	42 (10.5)	57 (14.25)	40 (10)	198 (49.5)	63 (15.75)	3.46
Farm visits	7 (1.75)	9 (2.25)	14 (3.5)	123 (30.75)	247 (61.75)	**4.49**
Group meetings	3 (0.75)	30 (7.5)	11 (2.75)	193 (48.25)	163 (40.75)	**4.21**
Durbars	48 (12)	64 (16)	24 (6)	202 (50.5)	62 (15.5)	3.42
Radio talks	61 (15.25)	60 (15)	27 (6.75)	159 (39.75)	93 (23.25)	3.41
Mean index for pruning						**3.79**
Home visits	47 (11.75)	61 (15.25)	52 (13)	188 (47)	52 (13)	3.34
Farm visits	5 (1.25)	15 (3.75)	26 (6.5)	133 (33.25)	221 (55.25)	**4.38**
Group meetings	3 (0.75)	22 (5.5)	35 (8.75)	183 (45.75)	157 (39.25)	**4.17**
Durbars	54 (13.5)	56 (14)	29 (7.25)	198 (49.5)	63 (15.75)	3.40

Radio talks	69 (17.25)	65 (16.25)	46 (11.5)	132 (33)	88 (22)	3.26
Mean index for mistletoe removal						**3.71**
Home visits	31 (7.75)	52 (13)	60 (15)	197 (49.25)	60 (15)	3.51
Farm visits	9 (2.25)	4 (1)	14 (3.5)	171 (42.75)	201 (50.25)	**4.38**
Group meetings	2 (0.5)	17 (4.25)	17 (4.25)	202 (50.5)	160 (40)	**4.26**
Durbars	46 (11.5)	60 (15)	42 (10.5)	183 (45.75)	69 (17.25)	3.42
Radio talks	65 (16.25)	51 (12.75)	36 (9)	161 (40.25)	87 (21.75)	3.39
Mean index for pest and disease						**3.79**
Home visits	40 (10)	54 (13.5)	51 (12.75)	197 (49.25)	58 (14.5)	3.45
Farm visits	6 (1.5)	12 (3)	17 (4.25)	119 (29.75)	245 (61.25)	**4.47**
Group meetings	7 (1.75)	23 (5.75)	22 (5.5)	183 (45.75)	165 (41.25)	**4.19**
Durbars	51 (12.75)	48 (12)	39 (9.75)	206 (51.5)	56 (14)	3.42
Radio talks	61 (15.25)	48 (12)	41 (10.25)	177 (44.25)	73 (18.25)	3.38
Mean index for fertilizer application						**3.78**
Home visits	39 (9.75)	61 (15.25)	79 (19.75)	159 (39.75)	62 (15.5)	3.36
Farm visits	12 (3)	12 (3)	16 (4)	167 (41.75)	193 (48.25)	**4.29**
Group meetings	3 (0.75)	22 (5.5)	24 (6)	220 (55)	131 (32.75)	**4.14**
Durbars	46 (11.5)	71 (17.75)	26 (6.5)	196 (49)	61 (15.25)	3.39
Radio talks	71 (17.75)	57 (14.25)	55 (13.75)	132 (33)	85 (21.25)	3.26
Mean index for pod and sanitary harvest						**3.69**
Overall perception index						**3.73**

Source: Field Data, 2022

*Scale of Agreement: Not very effective = 1, Not effective = 2, Neither Agree/Disagree = 3, Effective = 4, Very effective = 5

The overall perception index recorded is 3.73; this shows that the farmers marginally agreed to the statements that the extension delivery methods were effective. Two of the statements stood out regarding the effectiveness of extension delivery methods on all the good agronomic practices. For instance, for weeding, farm visits were effective (mean = 4.24), and group meetings were effective (mean = 4.10); both recorded means scored greater than four. However, the other statements recorded a mean score of around three, which shows that the farmers neither agree nor disagree (i.e., somewhat agree) with the statements that these extension delivery methods were effective: Home visits were effective (mean = 3.35); Durbars were effective (mean = 3.28); radio talks were effective (3.18). The foregoing pattern occurs in the relationship between delivery methods and the other good agronomic practices: Farmers agree that farm visits and group meetings were effective, but farmers neither agree nor disagree that home visits, Durbars, and radio talks were effective. [10] concluded in their study that group demonstrations and farmer-to-farmer extension are the most effective agricultural extension methods in their study area. The result from this study reveals that only farm visits and group meetings were perceived as effective in promoting good agronomic practices among the five extension delivery methods stated in this study. [7] emphasises the importance of providing ongoing training to extension agents to ensure they acquire sufficient knowledge and experience in adult learning principles. This training aims to enhance the effectiveness of extension agents in their roles. Regular farm visits and group meetings are crucial for the dissemination of messages about the practices, and therefore, they should be encouraged.

D. Analysis Of The Extent Of Adoption of Improved Agronomic Practices

TABLE V. EXTENT OF ADOPTION OF GOOD AGRONOMIC

Practices	**Never (1)**	**Sometimes (2)**	**Always (3)**	**Mean (SD)**
I do pruning.	39 (9.75)	126 (31.50)	235 (58.75)	2.49 (0.67)
I apply fertilizer.	11 (2.75)	128 (32)	261 (65.25)	2.625 (0.54)
I remove mistletoe.	22 (5.5)	118 (29.5)	260 (65.00)	2.595 (0.59)
I remove chupons.	19 (4.75)	119 (29.75)	262 (65.5)	2.608 (0.58)
I weed.	27 (6.75)	95 (23.75)	278 (69.50)	2.628 (0.61)
I control pest and diseases.	7 (1.75)	168 (42)	225 (56.25)	2.545 (0.53)
I do sanitary harvest.	20 (5)	189 (47.25)	191 (47.75)	2.428 (0.59)

Overall mean index				***2.560 (0.59)***

Source: Field Data, 2022
**Scale of agreement: Never=1, Sometimes= 2, Always=3.*

Table V shows the extent of the adoption of good agronomic practices by the cocoa farmers. The recorded overall mean index of 2.56 shows that the cocoa farmers always engage in all the good agronomic practices in the study area. Pruning recorded a mean of 2.49, which indicates that it is always practiced by the farmers in the study area. Cocoa farmers tend to always practice pruning for several reasons. Mostly, pruning maintains the health and productivity of the cocoa trees. Also, it allows farmers to control the height, width, and density of the trees, making them more manageable for cultivation, harvesting, and pest and disease management. A study by [37] revealed that pruning intercepts tree light and enhances growth and pod production. Also, weeding (2.628), fertiliser application (2.625), mistletoe removal (2.595), removal of chupons (2.608), and pests and diseases are always practiced by the farmers. However, sanitary harvesting recorded a mean of 2.428, which indicates that sanitary harvesting is sometimes practiced by the farmers in the study area. Farmers prioritise performing weeding themselves due to the labour-intensive nature of the task and the need for meticulous attention. Furthermore, their familiarity with their own fields and knowledge of the specific weed species present contribute to their decision to handle weeding personally. Additionally, hiring labour for weeding can be expensive and may not be a viable option for small-scale farmers who have limited resources. [27] indicates in their paper that fertiliser application is essential for replacing soil nutrients that are extracted via the annual harvest of cocoa pods. This suggests that one of the most important factors in optimising cocoa yield should be fertiliser use. Farmers of cocoa are continually encouraged to apply fertiliser, remove mistletoe, and conduct a clean harvest in order to promote healthy tree development, increase cocoa production, and preserve the overall productivity of cocoa plantations.

E. Extent Of Knowledge Acquisition On Improved Agronomic Practices From Extension Officers

TABLE VI. EXTENT OF KNOWLEDGE ACQUISITION ON IMPROVED AGRONOMIC PRACTICES FROM EXTENSION OFFICER

Practices	Low knowledge	Moderate knowledge	High knowledge	Mean (SD)
Pruning	39 (9.75)	127 (31.75)	234 (58.5)	2.488 (0.668)
Fertilizer application	11 (2.75)	128 (32)	261 (65.25)	2.625 (0.539)
Mistletoe removal	22 (5.5)	118 (29.5)	260 (65)	2.595 (0.593)
Chupon removal	19 (4.75)	119 (29.75)	262 (65.5)	2.607 (0.578)
Weeding from extension officer.	27 (6.75)	95 (23.75)	278 (69.5)	2.627 (0.608)
Control of pest and diseases	7 (1.75)	168 (42)	225 (56.25)	2.545 (0.533)
Pod and Sanitary harvest	20 (5)	190 (47.5)	190 (47.5)	2.425 (0.588)
Overall index				***2.55 (0.58)***

Source: Field Data, 2022
Scale: **1= Low knowledge, 2* **= Moderate knowledge** ***and 3*** **= High knowledge**

Table VI shows the extent of knowledge acquisition about good agronomic practices in cocoa production from the extension office. An overall mean index of 2.55 indicates that the cocoa farmers have a lot of knowledge about good agronomic practices from the extension officers. Though the farmers have little knowledge about pruning (mean = 2.488) and pod and sanitary harvest (mean = 2.425) from the extension officers, knowledge about fertiliser application (mean = 2.625), knowledge about mistletoe removal (mean = 2.595), knowledge about chupon (mean = 2.607), knowledge about weeding (mean = 2.627), and knowledge about pest and disease control (mean = 2.545) were a lot. This result shows that the farmers have a lot of knowledge about fertiliser application, mistletoe removal, chupon, weeding, pest and disease control, but have a little knowledge about pruning, pod, and sanitary harvest from the extension officers in the study area.

[29] claimed that farmers believe fertiliser use increases crop productivity. Their findings showed that the majority of farmers believe that fertiliser promotes growth. They clarified that it gives crops the essential nutrients they need, hastening their growth and development. Pruning, one of the most crucial tree management tasks, has a significant impact on the health and structure of trees. In addition to preserving the health of the tree, properly manicured trees also create a secure atmosphere and add aesthetic value. Higher expertise in pruning practice will result in a sense of awareness and a pleasant attitude when performing pruning labour [13].

F. Effect Of Extension Delivery Methods On Adoption Of Improved Practices

TABLE VII. EFFECT OF EXTENSION DELIVERY METHODS ON ADOPTION OF IMPROVED PRACTICES

Agronomic practices	Coefficient	Standard Error	t-value
Sex	0.038	0.206	0.19
Age	0.402^{***}	0.133	3.03
Educational level	0.313^{***}	0.101	3.11
Household size	0.050	0.059	0.85
Farm experience	0.009	0.014	0.63
Land size	-0.009	0.012	-0.81
Religion	0.064	0.173	0.37
Marital status	0.013	0.145	0.09
Home visit	0.006	0.193	0.03
Farm visit	0.495^{**}	0.214	2.13
Group meetings	0.454^{**}	0.203	2.24

Durbars	-0.068	0.216	-0.31
Radio talks	-0.197	0.185	-1.06
Constant	8.314***	0.809	10.27

**** p<.01, ** p<.05, * p<.1*

NB: Number of observations: 401; Pseudo R^2: 0.0298; Chi^2: 53.50; Prob > chi^2: 0.000

Table VII represents Tobit regression estimates of the relationship between the extension delivery methods and the adoption of the improved practices. The results show that, as expected, there is a positive relationship between age and the adoption of agronomic practices, and this is significant at the 1% level. This indicates that older age is related to better performance in agronomic practices. These findings disagree with [9], which shows that younger farmers tend to adopt more agronomic practices. They opened their minds to innovation and tried to gather more information as well as improve their knowledge.

The results of a test on the relationship between education and the adoption of improved practices indicate that there is a positive relationship between education and the adoption of improved practices. This is also significant at the 1% level. This implies that a higher level of education is related to higher performance in agronomic practices. For instance, a study by [23] mentions that education is an important tool governing farmers' adoption. Farmers' educational background affected their choice of suitable pesticide use methods.

Farm visits and group meetings have a significant positive relationship with the improved practices. Which means that farm visits and group meetings have a positive impact on agronomic practices. This relationship is significant at the 5% level. The significance of the relationship between farm visits, group meetings, and improved agronomic practices at the 5% level indicates a strong empirical association. This finding supports the notion that personalised and participatory extension approaches, involving farm visits and group meetings, have a positive effect on farmers' adoption of improved agronomic practices. The results indicate that an increase in these activities is associated with an improvement in agronomic practices. In other words, farmers whose farms are visited and those who participate in group meetings are more likely to exhibit better performance in implementing recommended agronomic practices. [31] claimed that the extension visits made to the farmers' farms in Bassawa village following the GAPs training had a favourable and significant impact. Their findings show that regular farm visits by extension personnel may accelerate smallholder farmers' adoption of new technologies.

Farm visits and group meetings provide opportunities for direct knowledge transfer from extension agents to farmers. During farm visits, extension agents can observe farmers' practices, identify areas for improvement, and provide tailored recommendations. Farm visits offer a hands-on learning experience for farmers. They can see firsthand how specific practices are implemented and observe the outcomes. This experiential learning approach can enhance farmers' understanding and confidence in adopting improved agronomic practices. Farm visits allow extension agents to provide tailored advice and support based on the specific needs and challenges of individual farmers. By understanding the unique circumstances of each farm, extension agents can provide recommendations that are contextually relevant and practical. This personalised approach increases the likelihood of successful adoption and implementation of improved agronomic practices.

Group meetings allow for the dissemination of information and the sharing of best practices among farmers. This knowledge transfer process is crucial for introducing and promoting improved agronomic practices. Group meetings provide a platform for farmers to learn from each other's experiences, fostering peer-to-peer knowledge exchange. When farmers witness the positive results and benefits of improved agronomic practices from their peers, they are more likely to adopt similar practices themselves. Peer influence can be a powerful motivator for behaviour change and the adoption of new practices.

G. Analysis Of The Constraints Associated With The Use Of Extension Delivery

TABLE VIII. CONSTRAINTS ASSOCIATED WITH THE USE OF EXTENSION DELIVERY

Constraint	**Mean Rank**	**Rank**
Extension agent to farmer ratio is very low	1.22	1
Lack of logistics/Inputs to enable extension officers train farmers	3.97	4
Inaccessible roads to farming communities	3.15	3
Lack of audio-visual gadgets in the remote areas	4.80	5
Finance to carry out some of the adopted adoption practices	1.86	2
N = 400		
Kendalls W = 0.866		
Chi-square = 1386.165		
Df = 4		
Asymp. Sig. = 0.0000		

Source: Authors' Construct, 2022

The Kendall Coefficient of Concordance is used to indicate the level of agreement among the raters on the constraints or challenges. The result is shown in Table VIII. Farmers ranked the identified difficulties among all 400 (100%) of the sampled farmers. The farmer-to-extension agent-to-farmer ratio is very low; there is a lack of finance to carry out some of the adopted adoption practices; inaccessible roads to farming communities; a lack of logistics and inputs to enable extension officers to train farmers; and a lack of audio-visual gadgets in the remote areas as 1st, 2nd, 3rd, 4th, and 5th, respectively. The result shows that the extension agent-to-farmer ratio is very low, which is the most pressing challenge associated with the use of extension delivery in the study area, with a mean rank of 1.22.

[1] claimed that the ratio of extension agents to farm families in developing nations has resulted in a situation where many farmers do not benefit from the service of extension agents. A

poor extension of agricultural technologies, low popularisation of innovation, and consequently low productivity will result from agricultural extension agents meeting as many farm families as they can, which could eventually have a negative impact on the farmer and his family as well as the country's economy. Finance is needed to implement some of the adopted adoption techniques with a mean rank of 1.86, as the extension agent-to-farmer ratio is quite low. [14] identified the factor that has the biggest impact on adoption as financial capability. With a mean ranking of 3.15, farmers identified impassable roads to farming communities as the third most urgent concern. The least urgent problems related to the use of extension delivery were evaluated as lacking logistics or inputs to enable extension agents to teach farmers and a lack of audio-visual equipment in remote locations, with mean ranks of 3.97 and 4.80, respectively. The results revealed that Kendall's coefficient of concordance was 86.6% and was significant at 1%. This means that there was a higher level of agreement among the farmers.

IV. CONCLUSION

This study has shown that the majority of the cocoa farmers in the study area are between 51 and 60 years old, with male dominance, and most of them are primary educated. Farm visits and group meetings are the most frequent extension delivery methods used for the dissemination of information on good agronomic practices (i.e., pruning, weeding, fertiliser application, mistletoe removal, pest and disease control, and pod and sanitary harvest). The overall perception index for the effectiveness of the extension delivery methods was 3.73, meaning that the majority of cocoa farmers marginally agreed to the perception statements that the extension delivery methods are effective. The overall mean index of 2.56 shows that cocoa farmers always engage in all the good agronomic practices. However, the overall mean index of the extent of knowledge acquisition about the good agronomic practices in cocoa production was 1.55, which indicates that most of the farmers have a lot of knowledge about the good agronomic practices in cocoa production from the extension officers. Though there was little knowledge about pruning and pod and sanitary harvest from the extension officers in the study area, The results from the tobit regression analysis show that farm visits and group meetings have a significant positive relationship with improved agronomic practices ($p<5\%$). Additionally, age and education were also found to have a positive relationship with the improved practices ($p< 1\%$). With a Kendall's W of 0.866, there was a higher level of agreement among the cocoa growers that the extension agent-to-farmer ratio is the main obstacle to using the extension delivery techniques.

To enhance agronomic practice, extension officers are advised to instruct and train farmers on weeding extension delivery methods. To improve agronomic practices, extension agents should routinely contact the farmers and instruct them in pod and sanitary education. While farm visits and group meetings were found to be effective, extension agents could explore and introduce additional extension delivery methods to ensure broader coverage and reach among cocoa farmers. This could include the use of modern technologies such as mobile applications, SMS services, and audio-visual tools, especially in remote areas where accessibility is a challenge.

REFERENCES

[1] Adeogun, S.O., Olawoye, J.E. and Akinbile, L.A., 2010. Information sources to cocoa farmers on cocoa rehabilitation techniques (CRTs) in selected states of Nigeria. *Journal of Media and Communication Studies*, *2*(1), p.9.

[2] Adler, E. S. and Clark, R. (2011). An invitation to social research: How it's done. Belmont, CA, USA: Wadsworth, Cengage Learning.

[3] Adu-Dapaah, H., Nkansah, K., & Afrane, S. K. (2013). Agricultural extension delivery in Ghana: A review of concepts, actors, models and policies. Journal of Agricultural Extension, 17(1), 1-17.

[4] Anderson, J.R., Bothell, D., Byrne, M.D., Douglass, S., Lebiere, C. and Qin, Y., 2004. An integrated theory of the mind. Psychological review, 111(4), p.1036.

[5] Aneani, F., Anchirinah, V. M., Asamoah, M. & Owusu-Ansah, F., 2012. Adoption of some cocoa production technologies by cocoa farmers in Ghana. Sustainable Agricultural Research, 1(1), pp. 103-117.

[6] Antwi-Agyei, P. and Stringer, L.C., 2021. Improving the effectiveness of agricultural extension services in supporting farmers to adapt to climate change: Insights from northeastern Ghana. Climate Risk Management, 32, p.100304.

[7] Aphunu, A. & Otoikhian, C. S. O. 2008. Farmers' perception of the effectiveness of extension agents of Delta State Agricultural Development Programme (DADP). Afr. J. Gen. Agric. 4(3):165-169.

[8] Asfaw, S., Shiferaw, B., Simtowe, F. and Lipper, L., 2012. Impact of modern agricultural technologies on smallholder welfare: Evidence from Tanzania and Ethiopia. *Food policy*, *37*(3), pp.283-295.

[9] Athipanyakul, T., and Pak-Uthai, W., 2012. Determinants of good agricultural practices (gap) adoption in the chili production system in Northeastern Thailand: A case of participatory approach. *International Journal of Environmental and Rural Development*, *3*(2), pp.175-180.

[10] Azumah, S.B., Donkoh, S.A. and Awuni, J.A., 2018. The perceived effectiveness of agricultural technology transfer methods: Evidence from rice farmers in Northern Ghana. *Cogent Food & Agriculture*, *4*(1), p.1503798.

[11] Baah, F. and Anchirinah, V., 2011. A review of Cocoa Research Institute of Ghana extension activities and the management of cocoa pests and diseases in Ghana. American Journal of Social and Management Sciences, 2(1), pp.196-201.

[12] Baah, F., Anchirinah, V. & Badu-Yeboah, A., 2009. Perceptions of extension agents on information exchange with cocoa farmers in the Eastern region of Ghana. Scientific Research and Essay, 4(7), pp. 694-699.

[13] Badrulhisham, N. and Othman, N., 2016. Knowledge in tree pruning for sustainable practices in urban setting: Improving our quality of life. *Procedia-Social and Behavioral Sciences*, *234*, pp.210-217.

[14] Baumgart-Getz, A., Prokopy, L.S. and Floress, K., 2012. Why farmers adopt best management practice in the United States: A meta-analysis of the adoption literature. Journal of environmental management, 96(1), pp.17-25.

[15] Deans, H., Ros-Tonen, M.A. and Derkyi, M., 2018. Advanced value chain collaboration in Ghana's cocoa sector: an entry point for integrated landscape approaches? Environmental management, 62(1), pp.143-156.

[16] Doss, C. R., Meinzen-Dick, R., & Quisumbing, A. R. (Eds.). (2020). Gender in agriculture: Closing the knowledge gap. Springer.

[17] Ghana Cocoa Board 2002. Report of the Committee on Application of High Technology" Method on Cocoa Production in Ghana. Accra: Ghana Cocoa Board.

[18] GSS 2021. Population and housing census: Preliminary report [Internet]. Ghana Statistical Service; September 22, 2021.

[19] Kelley, K., Clark, B., Brown, V. and Sitzia, J., 2003. Good practice in the conduct and reporting of survey research. International Journal for Quality in health care, 15(3), pp.261-266.

[20] Khorasani, M., Bezabih, M., & Tesfaye, W. (2021). Gendered social networks and agricultural technology adoption: Evidence from rural Ethiopia. World Development, 141, 105413.

[21] Ladele, A.A., 1998. Strategies to integrate youths in agricultural development in Nigeria. *Journal of Agricultural and Rural Management. Vols 3&4No*, *3*, pp.70-76.

[22] Manda, J., Alene, A.D., Tufa, A.H., Abdoulaye, T., Wossen, T., Chikoye, D. and Manyong, V., 2019. The poverty impacts of improved

cowpea varieties in Nigeria: A counterfactual analysis. *World Development*, *122*, pp.261-271.

[23] Maw, T., Leshan, J. and Aung, H.P., 2023. Assessing the adoption of good agricultural practices in muskmelon production in Chaung Oo Township, Myanmar. *Asian Journal of Agricultural Extension, Economics & Sociology*, *41*(3), pp.124-133.

[24] Ministry of Food and Agriculture, 2011. Directorate of Agricultural Extension Services: Agric. Ext. Approaches Being Implemented in Ghana. http://mofa.gov.gh/site/wpcontent/uploads/2011/03/Extensionapproaches- in-Ghana-.pdf.Accessed on 25th March, 2012.

[25] Mugera, A., Burton, M. and Downsborough, E., 2017. Consumer preference and willingness to pay for a local label attribute in Western Australian fresh and processed food products. *Journal of Food Products Marketing*, *23*(4), pp.452-472.

[26] Murhal, M. A., Hamad, M. A. A., & Kair, A. Y. M. (2019). Effectiveness of extension methods in adopting the planting of improved varieties of sorghum and millet in Sheikan locality, Sudan. Journal of Agricultural Science and Practice.

[27] Nunoo, I., Frimpong, B.N. and Frimpong, F.K., 2014. Fertilizer use among cocoa farmers in Ghana: the case of Sefwi Wiawso District. *International Journal of Environment*, *3*(1), pp.22-31.

[28] Nwaobiala, C. U., & Okpara, M. (2017). Effect Of Agricultural Extension Delivery Methods On Arable Crop Farmers' Cropping Systems In Kaduna State, Nigeria. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development Vol. 17, Issue 3.

[29] Obour, P.B., Dadzie, F.A., Kristensen, H.L., Rubæk, G.H., Kjeldsen, C. and Saba, C.K.S., 2015. Assessment of farmers' knowledge on fertilizer usage for peri-urban vegetable production in the Sunyani Municipality, Ghana. *Resources, Conservation and Recycling*, *103*, pp.77-84.

[30] Ogechi, U. J., 2017. Determinants of Utilization of Agricultural Extension Packages of Selected Arable Crops Among Farmers in Enugu State, Nigeria. Agricultural Research & Technology: Open Access Journal, 3(3), pp.73-80.

[31] Olayemi, S.S., Oko, A.A. and Oduntan, F.T., 2020. Adoption of appropriate good agricultural practices (GAPs) technologies among smallholder farmers in Nigeria. *International Journal of Agricultural Research, Sustainability, and Food Sufficiency*, *7*(2), pp.447-458.

[32] Owusu, V., Abdulai, A. L., Asante, B. O., & Fosu-Mensah, B. Y. (2018). Determinants of adoption of improved cocoa farming practices among farmers in the Atwima Nwabiagya District of Ghana. Journal of Development and Agricultural Economics, 10(4), 105-116.

[33] Reddy, P.K. and Ankaiah, R., 2005. A framework of information technology-based agriculture information dissemination system to improve crop productivity. *Current Science*, *88*(12), pp.1905-1913.

[34] Sandika, A.L. 2011 Knowledge and adoption toward „Golden Rules" in agrochemicals usage: A case of paddy farmers at Buttala area, Proceedings of 67th.

[35] Sayers, E.W., Barrett, T., Benson, D.A., Bolton, E., Bryant, S.H., Canese, K., Chetvernin, V., Church, D.M., DiCuccio, M., Federhen, S. and Feolo, M., 2010. Database resources of the national center for biotechnology information. Nucleic acids research, 39(suppl_1), pp.D38-D51.

[36] Tesfaye, K., Aggarwal, P.K., Mequanint, F., Shirsath, P.B., Stirling, C.M., Khatri-Chhetri, A. and Rahut, D.B., 2017. Climate variability and change in Bihar, India: challenges and opportunities for sustainable crop production. *Sustainability*, *9*(11), p.1998.

[37] Tosto, A., Zuidema, P.A., Goudsmit, E., Evers, J.B. and Anten, N.P., 2022. The effect of pruning on yield of cocoa trees is mediated by tree size and tree competition. *Scientia Horticulturae*, *304*, p.111275.

[38] Twumasi, Y.A., 2001, July. The use of GIS and remote sensing techniques as tools for managing nature reserves: the case of Kakum National Park in Ghana. In IGARSS 2001. Scanning the Present and Resolving the Future. Proceedings. IEEE 2001 International Geoscience and Remote Sensing Symposium (Cat. No. 01CH37217) (Vol. 7, pp. 3227-3229). IEEE.

[39] Vlaminck, J., Cools, P., Albonico, M., Ame, S., Chanthapaseuth, T., Viengxay, V., Do Trung, D., Osei-Atweneboana, M.Y., Asuming-Brempong, E., Karim, M.J. and Al Kawsar, A., 2020. Piloting a surveillance system to monitor the global patterns of drug efficacy and the emergence of anthelmintic resistance in soil-transmitted helminth control programs: a Starworms study protocol. Gates open research, 4.

[40] Yaro, J.A., 2013. The perception of and adaptation to climate variability/change in Ghana by small-scale and commercial farmers. *Regional Environmental Change*, *13*, pp.1259-1272.

[41] Danso-Abbeam, G., Aidoo, R., Agyemang, K.O., and Ohene-Yankyera, K., 2012 Technical efficiency in Ghana's cocoa industry: Evidence from Bibiani-Anhwiaso-Bekwai District. Journal of Development and Agricultural Economics Vol. 4(10), pp. 287- 294.

[42] Obisesan, A. 2014. Gender Differences in Technology Adoption and Welfare Impact among Nigerian Farming Households. MPRA Paper No. 58920.

[43] Tham-Agyekum, E. K., Ankuyi, F., Bakang, J. A., Quayson, N., Okantah, D., Hope, T., Osei-Nyarko, J., Wesley, R. R. (2023). Local Voices for Cocoa Production: Experiences of Ghanaian Cocoa Farmers on Community Radio, International Journal on Food, Agriculture, and Natural Resources, 4(1), pp. 34-43